

34. (New) The process for forming a metal interconnect as claimed in Claim 9, wherein the polishing slurry used in the second polishing step controls a polishing rate ratio of the insulating film to the barrier metal of 0.01 to 0.5, inclusive.

35. (New) The process of forming a metal interconnect as claimed in Claim 6, wherein the polishing slurry used in the second polishing step comprises an oxidizing agent.

36. (New) The process of forming a metal interconnect as claimed in Claim 35, wherein the polishing slurry used in the second polishing step comprises benzotriazole or its derivative.

37. (New) The process of forming a metal interconnect as claimed in Claim 9, wherein the polishing slurry used in the second polishing step comprises an oxidizing agent.

38. (New) The process of forming a metal interconnect as claimed in Claim 37, wherein the polishing slurry used in the second polishing step comprises benzotriazole or its derivative.

39. (New) The process of forming a metal interconnect as claimed in Claim 6, wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.

40. (New) The process of forming a metal interconnect as claimed in Claim 9, wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.

REMARKS

The Office Action has indicated that Claims 13-28 and 30-32 are allowed. It has objected to Claims 2-7, 9 and 12 but has indicated that they would be allowable if rewritten in

independent form. However, it has rejected Claims 1-8, and 10-11 under 35 U.S.C. §102(b) as defining subject matter which is allegedly anticipated by JP-08083780.

Applicants have amended and added claims, which, when considered with the comments hereinbelow are deemed to place the present case in condition for allowance. Reconsideration thereof is respectfully requested.

At the outset, prior to discussing the merits of the Office Action, applicants point out that they have amended Claim 1 by incorporating therein the subject matter of Claim 2. Claim 2 has been cancelled without prejudice. Claim 3 has been amended by incorporating the subject matter of Claim 1 therein. Claim 9 has been amended by incorporating therein the subject matter of Claims 1 and 8. Claim 12 has been amended by changing the dependency to Claim 1. Moreover, Claims 1, 3 and 5 have been amended by correcting the grammar therein.

Claims 33-40 have been added to the application. Claims 33 and 34 are dependent on Claims 6 and 9, respectively. Support thereof is found in original Claim 5. Support for Claims 35 and 36 is found in original Claims 10 and 11. Support for Claims 37 and 38 is found in original Claims 10 and 11. Support for Claims 39 and 40 is found in original Claim 12.

No new matter has been added to the application.

Claims 2 and 8 have been cancelled without prejudice. Moreover, as indicated hereinabove, Claim 1 has been amended by incorporating therein the subject matter of Claim 2. Thus, applicants have not abandoned original Claims 1 and 8 and reserve the right to file a continuation application directed thereto. However, in view of their cancellation, the rejection of Claim 8 and the objection to Claim 2 have been rendered moot.

A marked-up version showing the amendments to Claims 1, 3, 5, 6, 9 and 12 is attached hereto. It is entitled, “Version with Markings Showing Changes Made”.

Pursuant to the rejection of Claims 1, 8 and 10-11 under 35 U.S.C. §102(b), the Office Action cites JP-08083780.

Claim 1 is directed to, inter alia, a process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by the chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal of the barrier metal to 1 to 3 inclusive, until the surface of the insulating film other than the concave is substantially completely exposed, wherein polishing is conducted such that the interconnect metal film remains in 5% to 30% inclusive of the surface area other than the concave.

The Japanese reference discloses an abrasive and polishing method for polishing a substrate composed of a silicon substrate and a silicon oxide film and carbon film successively formed on the silicon substrate. In the process described therein, grooves for wiring, openings for continuous wirings and the like are formed in both the silicon oxide film and the carbon film by patterning, and a titanium nitride film and copper film are successively formed on the surface of the substrate. The copper film has recesses and projecting sections thereon, and it is formed at

a high polishing speed by filling up the recessed section by using a chemimechanical polishing method using an abrasive prepared by dispersing silica particles as abrasive particles in a mixed solution of a glycine and hydrogen peroxide and adding benzotriazole to the mixed solution. It is alleged that this method also suppresses the occurrence of dishing.

It is respectfully submitted that the prior art does not disclose or teach the subject matter of pending Claim 1.

Anticipation requires that the prior art reference disclose each and every element of the claim. Kalman v. Kimberly Clark Corp., 713 F2d 760, 771, 218 USPQ 781, 789 (Fed. Cir. 1983). The absence of any one element negates anticipation. Id., 713 F2d at 771-772, 218 USPQ at 789.

There are differences between the present invention and the prior art references. For example, the reference fails to teach or disclose that a polishing step is conducted such that the interconnect metal film remains in 5% to 30% inclusive of the surface area other than the concave. A review of the cited reference clearly reveals that this subject matter is not described in the cited prior art. It is respectfully submitted that the Office Action concurs, especially since Claim 1 incorporates the subject matter Claim 2 and since the Office Action has indicated that Claim 2 is allowable if written in independent form. Thus, the rejection of Claim 1 under 35 U.S.C. §102(b) is overcome; withdrawal thereof is respectfully submitted.

Claims 10-11 are dependent upon Claim 1. Since Claim 1 is no longer rejected, it is respectfully submitted that Claims 10-11 are also allowable. Claim 8 has been cancelled and therefore the rejection thereof has been rendered moot. Therefore, for the reasons given herein, the rejection of Claims 1, 8 and 10-11 under 35 U.S.C. §102(b) is overcome; withdrawal thereof

is respectfully requested.

Claims 3, 6 and 9 have been amended by making them independent and including all of the limitations of Claim 1 upon which they are dependent. Thus, the objection thereto has been overcome.

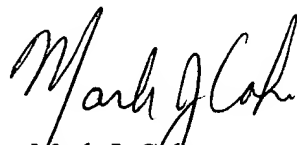
In addition, Claim 1 has been amended by incorporating therein the subject matter of original Claim 2.

Since, Claims 4, 5, 7 and 12 are dependent upon Claim 1, 3, 6 or 9 and since the amendment to Claim 1 overcomes the rejection and Claims 4, 5, 7 and 12 are no longer dependent upon a rejected claim. Thus, the objection thereto is overcome.

Thus, the objection to Claims 3-7, 9 and 12 is overcome; withdrawal thereof is respectfully requested.

It is respectfully submitted that the present case is in condition for allowance; which action is earnestly solicited.

Respectfully submitted,

A handwritten signature in black ink, appearing to read "Mark J. Cohen". The signature is fluid and cursive, with the first letters of the first and last names being capitalized and prominent.

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“VERSION WITH MARKINGS SHOWING CHANGES MADE”

IN THE CLAIMS:

Claims 2 and 8 have been cancelled without prejudice.

Claims 33-40 have been added.

Claims 1, 3, 5, 6 and 9 have been amended as follows:

1. (Amended) A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal to the barrier metal [to] of 1 to 3 [both] inclusive, until the surface of the insulating film other than the concave is substantially completely exposed, wherein the first polishing step is conducted such that the interconnect metal film remains in 5% to 30% inclusive of the surface area other than the concave.

3. (Amended) A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of

polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal to the barrier metal of 1 to 3 inclusive, until the surface of the insulating film other than the concave is substantially completely exposed [The process for forming a metal interconnect as claimed in Claim 1], wherein in the first polishing step, the polishing slurry comprises a polishing material, an oxidizing agent, an organic acid and an alkanolamine represented by general formula (1):

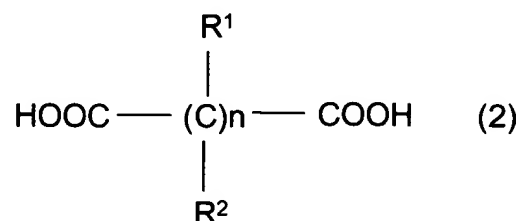


wherein R^1 is hydrogen or alkyl having 1 to 5 carbon atoms; R^2 is alkylene having 1 to 5 carbon atoms; m is an integer of 0 to 2 [both] inclusive; and n is a natural number of 1 to 3 [both] inclusive, provided that $m+n$ is 3.

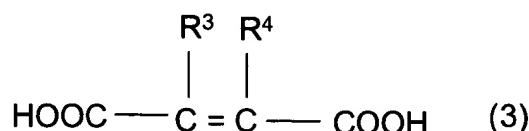
5. (Amended) The process for forming a metal interconnect as claimed in Claim 1, wherein the polishing slurry used in the second polishing step controls a polishing rate ratio of the insulating film to the barrier metal [to] of 0.01 to 0.5 [both] inclusive.

6. (Amended) A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal to the barrier metal of 1 to 3 inclusive,

until the surface of the insulating film other than the concave is substantially completely exposed
 [The process for forming a metal interconnect as claimed in Claim 1], wherein the polishing slurry used in the second polishing step comprises a silica polishing material and a carboxylic acid represented by general formula (2):



wherein n is 0, 1, 2 or 3 and each of R¹ and R² is, independently for a carbon atom to which it attaches, hydrogen, -OH or -COOH; or general formula (3):



where each of R³ and R⁴ is independently hydrogen or -OH.

9. (Amended) A process for forming a metal interconnect comprising the steps of forming a concave in an insulating film formed on a substrate, forming a barrier metal film on the insulating film, forming an interconnect metal film over the whole surface such that the concave is filled with the metal and then polishing the surface of the substrate by the chemical mechanical polishing, characterized in that the polishing step comprises a first polishing step of polishing the surface such that the interconnect metal film partially remains on the surface other than the concave and a second polishing step of polishing the surface using a polishing slurry controlling a polishing-rate ratio of the interconnect metal to the barrier metal of 1 to 3 inclusive, until the surface of the insulating film other than the concave is substantially completely exposed

[The process for forming a metal interconnect as claimed in Claim 8], wherein the polishing slurry used in the second polishing step comprises a silica polishing material and an inorganic salt, and wherein the inorganic salt in the polishing slurry used in polishing is at least one selected from the group consisting of a hydroacid salt, an oxo acid salt, a peroxy acid salt and a halogen oxo acid salt.

12. (Twice Amended) The process for forming a metal interconnect as claimed in Claim [2] 1 wherein the barrier metal film is a tantalum-containing metal film and the interconnect metal film is a copper or copper alloy film.